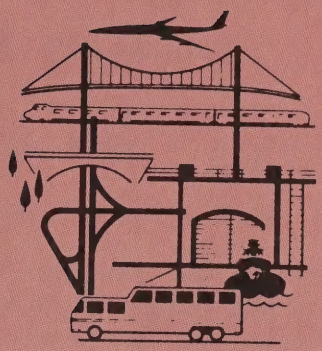
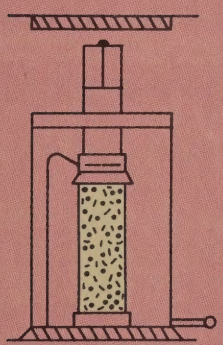
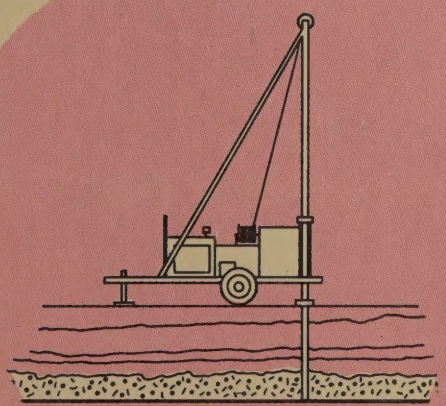
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS
BUREAU







SOUTHERN TIER EXPRESSWAY SECTION 5N
PIN 5118.01 CATTARAUGUS COUNTY

CONCEPTUAL REPORT FOR EMBANKMENT RETAINING WALL SECTIONS ALONG THE ALLEGHENY RIVER

AUGUST, 1980

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE August 18, 1980

SUBJECT SOUTHERN TIER EXPRESSWAY SECTION 5N
CONCEPTUAL REPORT FOR EMBANKMENT RETAINING WALL SECTIONS
ALONG THE ALLEGHENY RIVER
PIN 5118.01 CATTARAUGUS COUNTY

FROM L. H. Moore, Soil Mechanics Bureau, Rm. 102, Bldg. 7
By: B. E. Butler

TO R. K. Radliff, Preliminary Plan Rev. Bureau, Rm. 408, Bldg. 5

Transmitted herewith is our report on this subject for review and transmittal to FHWA. This submission follows the direction and scope agreed to during a meeting on July 30, 1980. A summary of the meeting was transmitted in a memorandum from your Mr. J. Tierney to Mr. E. P. Mueller of Region 5. The hydraulics data which you desired to be included in our report has been added as an appendix.

We are available to provide your office and the Region with any assistance possible to further the progression of this project.

BEB:mvm
Attachment

NYSDOT
Library
50 Wolf Road, POD 34
Albany, New York 12232

SOUTHERN TIER EXPRESSWAY SECTION 5N
CONCEPTUAL REPORT FOR EMBANKMENT RETAINING WALL SECTIONS
ALONG THE ALLEGHENY RIVER
PIN 5118.01 CATTARAUGUS COUNTY

I. Introduction

This report has been prepared in response to a request from the FHWA to the Department to provide proposed foundation design concepts for constructing the alignment in a wall section at certain locations. Walls are required in these instances rather than a normal embankment section which would encroach excessively into the Allegheny River Valley. This report discusses the major factors which led to selection of a wall type and related design items.

The reference materials for this study include plans and representative cross-sections supplied by the Regional Office; the results of a preliminary explorations program consisting of borings done by the Region's Soil Section and a seismic survey by this Bureau, both performed a number of years ago; a terrain reconnaissance report prepared by this Bureau; a geologic review at proposed retaining wall areas made by this Bureau's geologists; site inspections by personnel of this Bureau in conjunction with the Region; and results of pertinent project design decisions made at formal and informal conferences.

II Site and General Geologic Conditions

The specific wall sites covered in this report are four in number and are designated as areas "A" through "D". Reference to Figure 1 shows their plan locations along the alignment and respective approximate station limits. In general the wall at each location is adjacent to the river and retains the embankment against the steeply sloping

southerly hillside. Each of the walls is located just beyond the toe of the hillside in the flat river valley.

The project area was influenced by four ice advances that stopped within a few miles north of it and by at least two others that stopped further north. The center of the pre-glacial valley is 300± feet below the surface of the present valley floor in this area and is filled with a sequence of colluvium, lake sediments and outwash deposits. The surficial outwash deposit is over fifty feet thick in most places.

During the interglacial erosional periods greater or lesser amounts of the older deposits were removed by the river. During these erosional intervals the river cut into the rock walls of the valley at various points removing spurs and leaving rock benches. The proposed wall areas on the river side are to be located for the most part on such benches.

In wall area "A" the river has been pushed into the south side of the valley in part by the action of Great Valley Creek and is now in the process of becoming incised into the rock from a point just upstream of the bend opposite centerline station 1050± downstream to a point near the confluence with Great Valley Creek where the rock drops some ten to fifteen feet onto an older bench cut during a previous erosional period. From the confluence of Great Valley Creek the river moves away from the valley wall and the channel is completely out of rock by some 1500± feet downstream. A diagramatic section representing these conditions in the Wall "A" area is shown in Figure 2.

Wall areas "B", "C" and "D" are in the area where the river is presently cutting into the valley wall. In areas "B" and "C" the river

bottom is on or close to rock part way across the channel for the entire length of the areas, except possibly the northernmost section of wall area "B". In area "D" the river bottom at the south end of the area where it approaches the valley wall is on outwash, on or close to rock partway across the channel in the central section and on outwash over colluvium at the northern end where it crosses a ravine coming down the side of the valley. Older lower level benches from previous erosional intervals probably exist in these areas. Insufficient preliminary explorations data at this time prevents the presentation of a geologic diagramatic section representative of these wall areas.

III Subsurface Conditions

Subsurface conditions at each of the wall locations are similar. In general, a relatively thin mantle of colluvium and residual soil overlies steeply sloping bedrock on the hillsides with shallow alluvial deposits of sandy gravel over outwash or bedrock beneath where the roadway cross-section extends into the river valley.

The boring contract in progress is expected to be completed in late fall of this year. This new data will provide a more detailed definition of soil and rock conditions for design of the entire project. However, a major, previously identified design problem is the relative instability of the overburden overlying the bedrock on the steep hillsides. This situation establishes an important design constraint which is to eliminate cutting into the hillside above the abandoned railroad alignment unless such cut slopes can be extended to daylight. This latter condition is depicted on the typical section for Wall Area "B" on Figure 3. A typical section for the three other wall areas which avoids cutting into the hillside is also shown on Figure 3.

IV Design Constraints

Earlier alignment studies east and south of Salamanca provided for an embankment section occupying a significant area within the present Allegheny River flood plain. This scheme intended to compensate for the lost flow area primarily by providing overflow channels and channel widenings where necessary on the north side of the river. This alignment proposal was ruled unacceptable because of a number of factors including flooding and environmental concerns, disruption of archaeological sites and disputes with the Seneca Indian Nation.

Subsequent design studies provided for minimum encroachment of the embankment into the river by utilizing retaining walls. The Region designers established a grade line and cross-section with a wall on the river side which would satisfy the major design constraints; eliminating partial cuts into the hillside and limiting the maximum encroachment into the river to about 70 feet and an average of about 40 feet. One version of this design considered two wall sections, the major wall on the river side and a second wall near centerline which would retain the eastbound roadway at a higher level. A final evaluation, however, resulted in a section with one major wall on the river side as shown in Figure 3. The minor wall shown adjacent to the hillside would be used only where necessary to provide a ditch for drainage, wild animal protection or where right-of-way is limited.

V Retaining Wall Design Concepts

From an economic standpoint we have found that reinforced earth wall structures are much less expensive than conventional concrete designs for

high and long walls. The former are also aesthetically pleasing. Their performance also presents advantages from the foundations viewpoint. For example, these walls when constructed on suitable in-situ foundations soils can tolerate both uniform and some differential settlement without experiencing or exhibiting signs of distress. This is due largely to the ability to articulate within the extensive horizontal and vertical joint systems. Another advantage for this type of wall is the ease with which they are built in a small, restricted area since labor and equipment requirements are minimal. This is particularly important here because of the limited work access area during construction of the lower portions of the wall.

Our familiarity and satisfaction with reinforced earth is based on extensive usage and performance. The Department has already specified reinforced earth on nine projects up to the present. Many of these projects have been completed and are in service. There are also a number of new reinforced earth projects in various stages of design.

Although the above reflects our satisfaction and confidence in using reinforced earth for this project, this would be our first river installation. Consequently, there were a number of additional aspects which required analysis and resolution to account for associated river design factors. Fortunately, the maximum river velocity adjacent to the wall sections is only in the order of eight feet per second. This figure covers both the 100 year design flood and tropical storm Agnes which exceeded the 100 year flow conditions. Included in the Appendix to this report is an hydraulic analysis for the Allegheny River prepared by the Bridge Division which shows this information.

Our study for scour protection for the wall using the Department's Manual SDP-2 "Bank and Channel Protection Lining Design Procedures" indicated that medium stone fill would be adequate to guard against wall undermining by scour. There is the possibility, however, that we may take a more conservative course in the final design and recommend that the outer stone layer exposed to river flow be heavy stone fill material.

The bottom elevation for the reinforced earth walls will also be determined after further study. Factors involved in this decision include the minimum depth necessary below the stone fill for scour protection, a balance between the cost of setting the wall at a lower elevation versus the cost of excavating into the lower slope and back-filling with granular material to accommodate the necessary strip lengths and finally; avoiding having to build the bottom part of the wall in no more than two to three feet of water. By using "Ordinary Water" as a reference, the lowest bottom of wall elevation could be set at about elevations, 1370, 1372, 1373 and 1375 at Wall Areas A through D, respectively. Here again, reinforced earth walls present a construction advantage applicable to this project since temporary inundation due to high water has little effect on previously completed wall work. Incidental excavation into the lower existing slope where required to accommodate the reinforcing strips and backfill is not considered a problem and not in the same category as cutting into the steeper hillside above the abandoned railroad alignment.

We have considered the longevity of the galvanized reinforcement strips as affected by corrosion. Corrosion studies performed by the State

of Georgia and a review by this Department's Engineering Research and Development Bureau conclude that this concern is conservatively accounted for in the strip design. These galvanized strips have sufficient sacrificial material to be structurally adequate well beyond 100 years, even at higher than expected corrosion rates.

Of course, the reinforced earth wall would be provided with filter fabric attached to its inside face. This will prevent any potential loss of backfill material through the joints either from a "plucking" action by river flow or from internal drainage behind the wall.

We are confident that the reinforced wall and scour protection system is the most appropriate design concept for walls on this project. Even though this would be the Department's first installation in or adjacent to water we have reviewed construction and performance information for reinforced earth walls constructed in the Mississippi River, in various lakes and ocean coastal regions. Consequently, we feel assured that these walls located adjacent to the slow moving Allegheny River do not present any unusual design or construction difficulties.

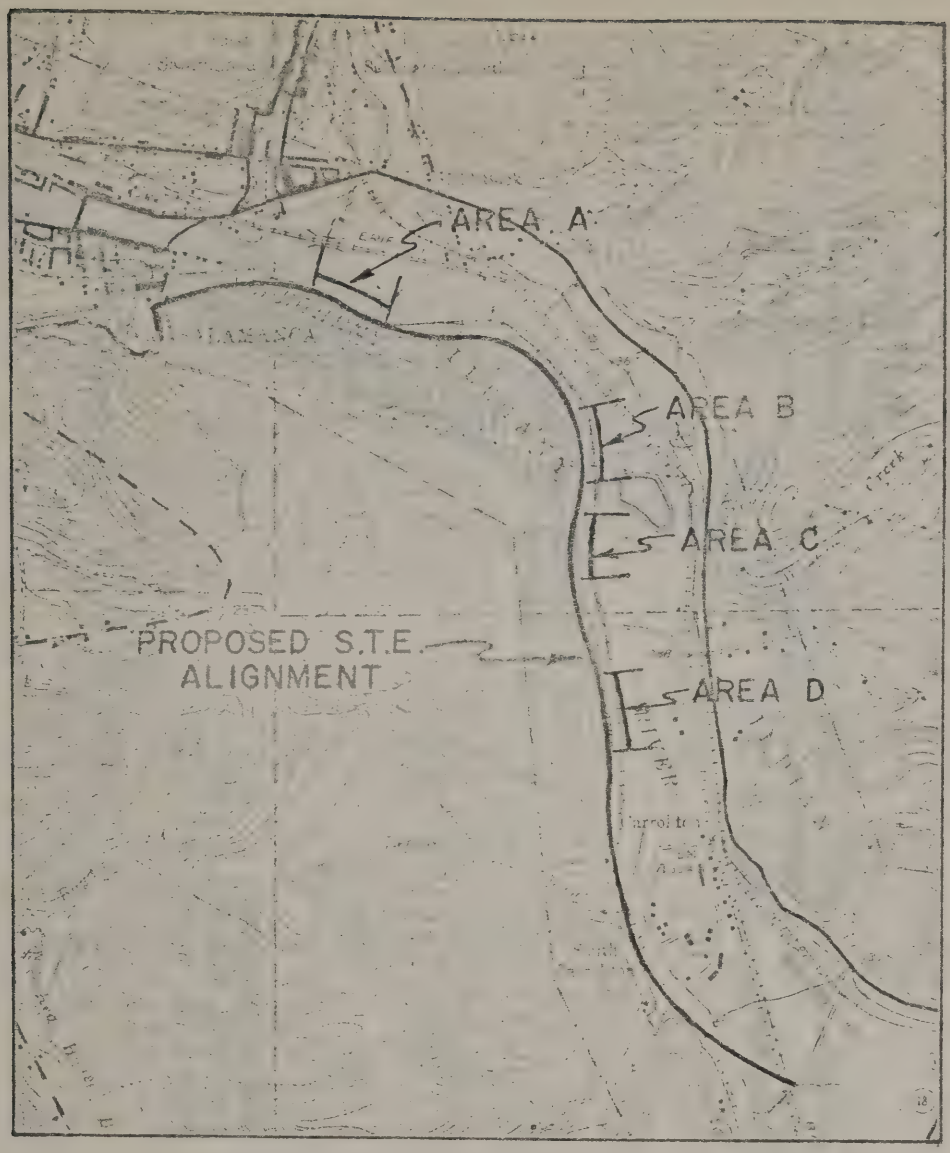
VI Summary

This report summarizes the foundation design studies performed to date which provide the basis for selecting the reinforced wall design concept at the locations indicated. We believe all design, cost and construction aspects have been considered to the extent necessary to justify using reinforced earth walls for this project.

More detailed plans and the results of the on-going boring program will be required to finalize our foundation studies. This work can be accomplished in a short period of time after receipt of this information.

APPENDIX

Water Surface Profile
Allegheny River (HEC-2 Program)
Cattaraugus County



WALL LOCATION DATA

WALL AREA	APPROX. STA. LIMITS
A	E 1026 TO 1049
B	E 1107 TO 1128+50
C	E 1138 TO 1153
D	E 1185 TO 1202+50

27
21
15
17
8000'

FIGURE 1

PROJECT AND WALL AREA LOCATION PLAN

SOUTHERN TIER EXPRESSWAY, SECT. 5N

P.I.N. 5118.01 CATTARAUGUS CO.

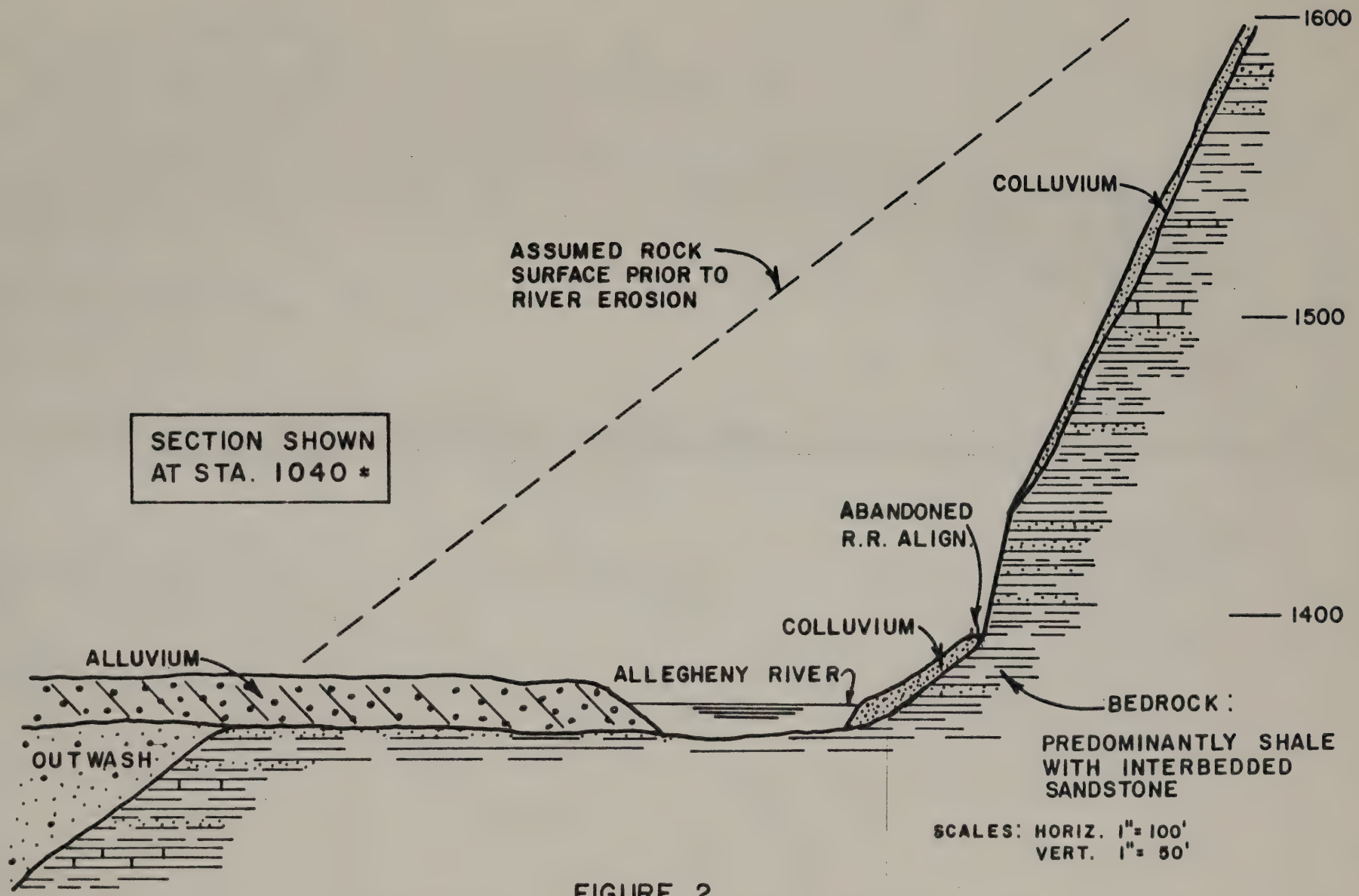
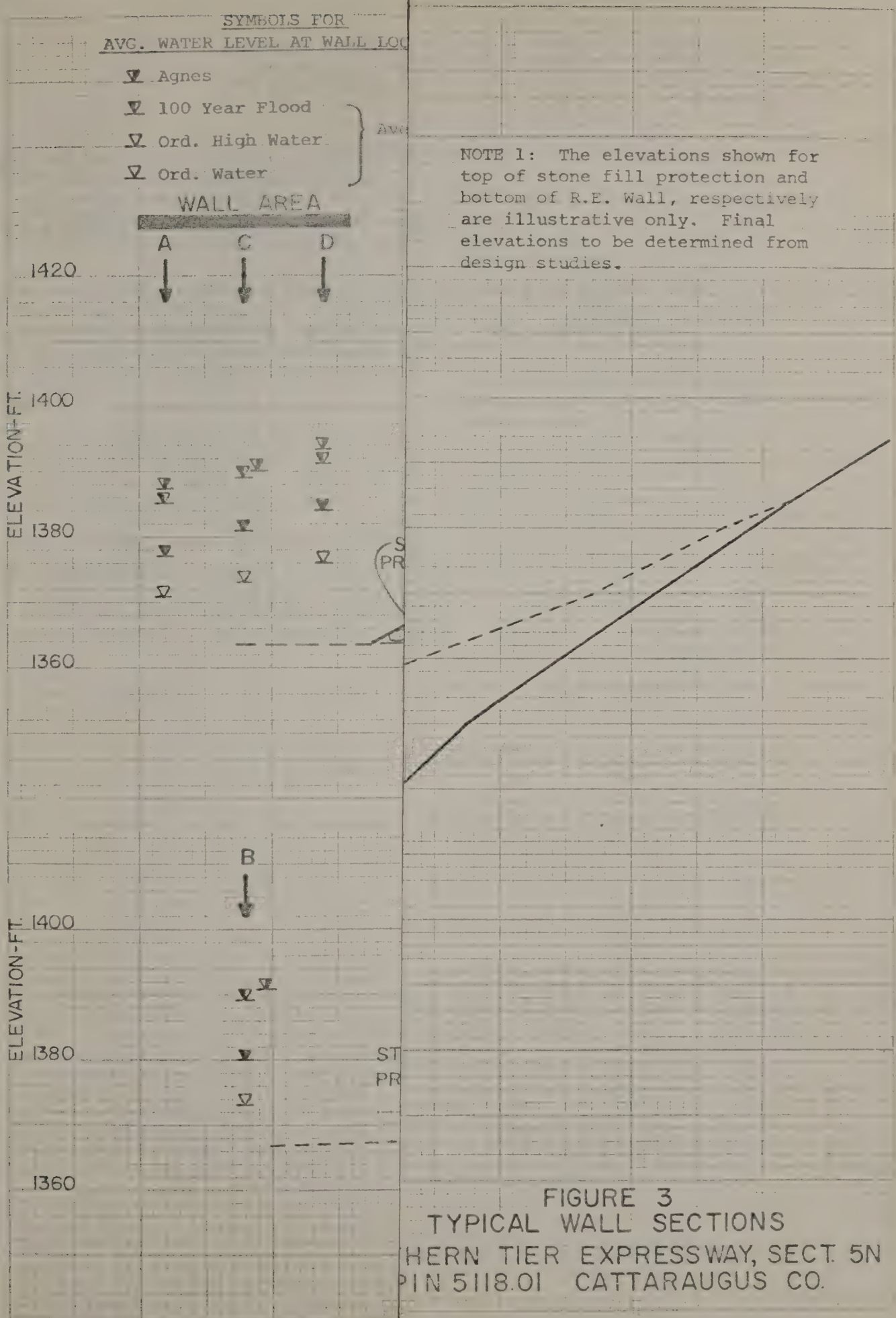


FIGURE 2

DIAGRAMATIC SECTION - WALL AREA "A"

SOUTHERN TIER EXPRESSWAY, SECT. 5N

P.I.N. 5118.01 CATTARAUGUS CO.



NOTE 1: The elevations shown for top of stone fill protection and bottom of R.E. Wall, respectively are illustrative only. Final elevations to be determined from design studies.

FIGURE 3
TYPICAL WALL SECTIONS
HERN TIER EXPRESSWAY, SECT. 5N
PIN 5118.01 CATTARAUGUS CO.

SYMBOLS FOR
AVG. WATER LEVEL AT WALL LOCATION

- Agnes
- 100 Year Flood
- Ord. High Water
- Ord. Water

} Averages

WALL AREA

A C D

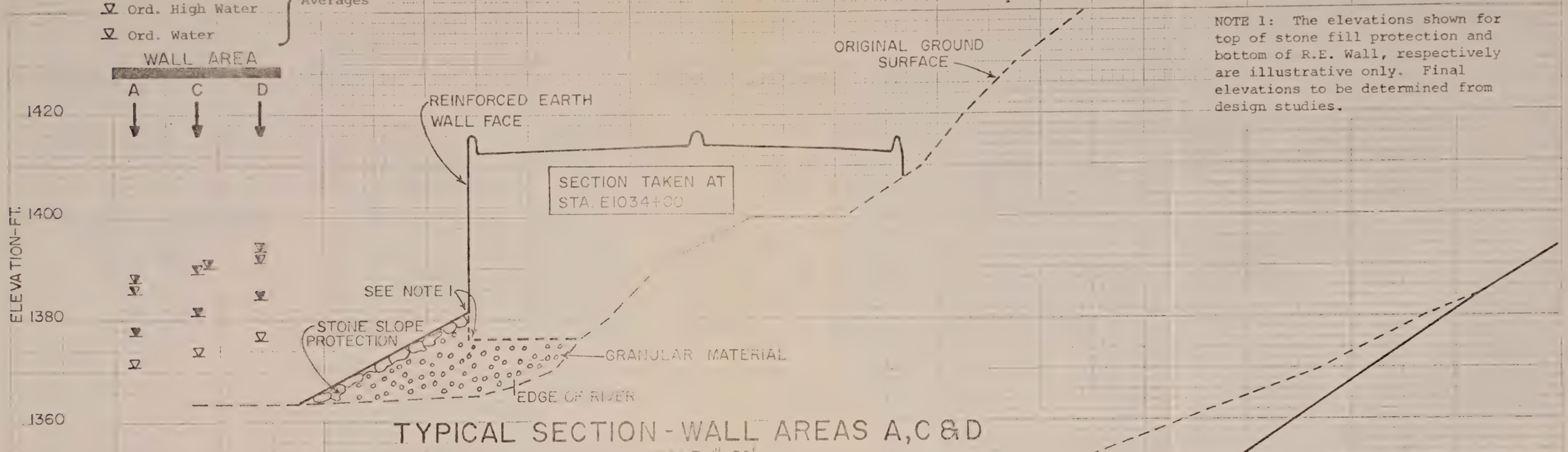
ELEVATION-FT.

1420

1400

1380

1360



TYPICAL SECTION - WALL AREAS A,C & D

SCALE 1"=20'

NOTE 1: The elevations shown for top of stone fill protection and bottom of R.E. Wall, respectively are illustrative only. Final elevations to be determined from design studies.

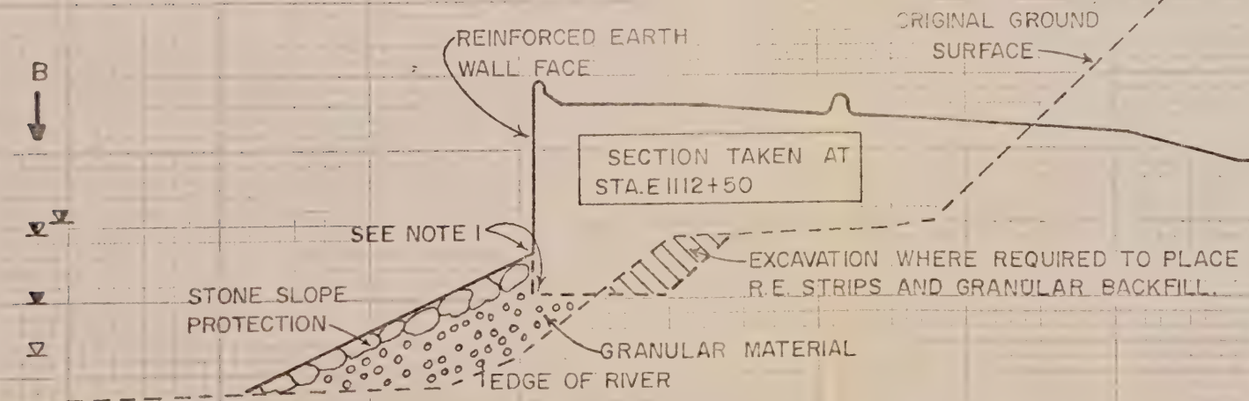
B

ELEVATION-FT.

1400

1380

1360



TYPICAL SECTION - WALL AREA B

SCALE 1"=20'

FIGURE 3
TYPICAL WALL SECTIONS
SOUTHERN TIER EXPRESSWAY, SECT. 5N
PIN 5118.01 CATTARAUGUS CO.

ALLEGANY RIVER - HYDRAULICS
SALAMANCA TO ALLEGANY
CATTARAUGUS COUNTY

As a part of the NYSDOT studies relating to the location of the Southern Tier Expressway within the Allegany River Valley it was necessary to have information about the hydraulics of the river. The Department's Structures Division determined the most appropriate method would be to utilize its HEC-2 computer program to calculate water surface profiles.

The Department's HEC-2 studies adapted the original model used by the Corps of Engineers in 1974 to compute the floodway between Salamanca and Allegany for their Flood Insurance Study (which was finalized in part by NYSDEC in 1976). The COE model utilized previously measured sections in the flood plain together with data from the 1967 and 1972 (Agnes) floods to calibrate the HEC-2.

The Structures Division added the various Allegany River Flood plain encroachments such as the walls, highway fills and bridge structures and computed the water surface elevations for the Q100 year and the Q1972 floods that would accompany the construction of the STE.

The following tables list the existing (before) and with STE (after) water surface elevations and average channel relocations for 100 year and the 1972 floods and the difference between these conditions. The Section Numbers shown in the tables are the River Sections as originally labeled by the Corps of Engineers and shown on the accompanying map.

Q100 - ALLEGANY RIVER-CATTARAUGUS COUNTY

	SECTION NUMBER	WATER ELEV. EXIST.	WATER ELEV. WITH STE	DIFF. OF WATER EL.	CHANNEL VEL. EXIST.	CHANNEL VEL. WITH STE	DIFF. IN CH. VEL.
	230.3	1383.6	1383.6	0	7.6	7.6	0
	230.5	1384.9	1384.9	0	6.9	6.9	0
WALL	230.6	1384.9	1384.9	0	7.8	8.3	+.5
WALL	230.7	1385.2	1385.2	0	7.6	8.0	+.5
WALL	230.8	1386.4	1386.6	.2	7.1	7.4	+.3
	230.9	1386.5	1386.8	.3	6.7	6.6	-.1
	231.43	1386.8	1383.1	.3	6.5	6.4	-.1
	231.57	1387.2	1387.5	.3	4.1	4.1	0
	231.73	1387.3	1387.5	.2	5.5	5.4	-.1
	232.04	1387.6	1387.9	.3	5.8	5.6	-.2
	232.38	1388.0	1388.2	.2	6.0	5.9	-.1
	232.5	1388.3	1388.4	.1	5.9	5.8	-.1
WALL	232.6	1388.5	1388.7	.2	4.1	4.3	+.2
WALL	232.83	1388.6	1388.9	.3	4.1	4.2	+.1
WALL	232.9	1388.7	1389.0	.3	4.0	4.2	+.2
	233.0	1388.7	1389.0	.3	4.0	3.9	-.1
	233.1	1388.8	1389.0	.2	4.0	3.9	-.1
WALL	233.2	1388.8	1389.0	.2	5.7	6.2	+.5
WALL	233.23	1388.9	1389.1	.2	5.6	6.1	+.5
WALL	233.3	1389.0	1389.3	.3	5.6	6.0	+.4
	233.4	1388.8	1389.1	.3	7.3	7.0	-.3
	233.94	1390.3	1390.5	.2	6.4	6.3	-.1
	234.0	1390.7	1390.9	.2	6.1	6.1	0
WALL	234.1	1390.8	1390.9	.1	5.8	6.3	-.5
WALL	234.28	1391.7	1392.1	.4	5.3	5.6	+.3
WALL	234.3	1391.9	1392.2	.3	5.2	5.6	+.4
	234.4	1392.0	1392.4	.4	5.5	5.3	-.2
	234.83	1393.4	1393.7	.3	4.8	4.7	-.1
	235.5	1394.9	1395.2	.3	4.8	4.7	-.1
	127.5	1395.0	1395.2	*.2	4.8	4.7	-.2
NEW BRIDGE	133.5	1395.2	1395.4	.2	2.7	3.0	.3
	158.5	1395.4	1396.0	.6	3.6	4.6	1.0
	182.5	1395.6	1396.5	.9	3.0	3.3	.3
	190.5	1395.8	1396.6	.8	1.8	2.0	.2
	203.0	1395.8	1396.6	.8	5.0	5.5	.5
	205.0	1395.8	1396.6	.8	4.9	5.6	.7
	206.0	1395.8	1396.7	.9	4.6	5.0	.4
	209.0	1396.2	1397.0	.8	1.3	3.2	1.9
NEW BRIDGES	224.0	1396.2	1397.2	1.0	2.8	3.3	.5
	239.0	1396.1	1397.4	1.3	10.0	6.6	-3.4
	240.0	1396.2	1397.4	1.2	10.0	6.6	-3.4
	249.0	1397.5	1397.9	.4	8.5	5.9	-2.6
	269.0	1399.1	1398.8	-.3	3.5	6.6	3.1
	304.5	1399.4	1400.2	.8	2.7	2.7	0
	329.0	1399.8	1400.5	.7	4.2	4.3	.1
	363.5	1401.1	1401.9	.8	4.6	5.2	.7
	396.0	1402.6	1403.7	1.1	7.6	7.5	-.1
	432.5	1405.7	1406.4	.7	6.1	5.6	-.5
	460.0	1407.5	1408.0	.5	5.5	5.3	-.2
	488.0	1408.4	1408.8	.4	6.9	6.7	-.2

*Backwater from Wall System.

Q100 - ALLEGANY RIVER-CATTARAUGUS COUNTY

SECTION NUMBER	WATER ELEV. EXIST.	WATER ELEV. WITH STE	DIFF. OF WATER EL.	CHANNEL VEL. EXIST.	CHANNEL VEL. WITH STE	DIFF. IN CH. VEL.
514.0	1409.5	1409.8	.3	6.4	6.3	-.1
537.0	1410.3	1410.5	.2	8.7	8.5	-.2
244.6	1411.0	1411.1	.1	7.9	7.8	-.1
NEW BRIDGE → 244.89	1411.8	1411.9	.1	7.4	7.3	-.1
245.34	1413.1	1413.5	.4	6.9	6.7	-.2
245.78	1414.0	1414.4	.4	5.7	5.4	-.3
246.2	1414.7	1415.0	.3	6.3	6.2	-.1
246.67	1415.5	1415.7	.2	6.2	6.1	-.1
246.67	1416.0	1416.3	.3	8.6	8.6	0
247.0	1416.7	1416.9	.2	4.6	4.6	0
247.37	1417.0	1417.2	.2	7.8	7.8	0
247.38	1418.0	1418.1	.1	4.2	4.2	0
247.78	1418.5	1418.6	.1	5.4	5.3	-1
248.17	1418.9	1419.0	.1	5.1	5.1	0

Q1972 - ALLEGANY RIVER-CATTARAUGUS COUNTY

	SECTION NUMBER	WATER ELEV. EXIST.	WATER ELEV. WITH STE	DIFF. OF WATER EL.	CHANNEL VEL. EXIST.	CHANNEL VEL. WITH STE	DIFF. IN CH. VEL.
	230.3	1385.7	1385.7	0	7.7	7.7	0
	230.5	1386.8	1386.8	0	7.1	7.1	0
WALL	230.6	1386.8	1386.8	0	8.1	8.5	+0.4
WALL	230.7	1387.2	1387.2	0	7.9	8.3	+0.4
WALL	230.8	1388.3	1388.5	.2	7.6	7.9	+0.3
	230.9	1388.4	1388.7	.3	6.9	6.8	-0.1
	231.43	1388.7	1389.0	.3	6.8	6.6	-0.2
	231.57	1389.1	1389.4	.3	4.3	4.2	-0.1
	231.73	1389.2	1389.4	.2	5.7	5.6	-0.1
	232.04	1389.6	1389.8	.2	5.8	5.7	-0.1
	232.38	1389.9	1390.1	.2	6.2	6.1	-0.1
	232.5	1390.1	1390.3	.2	6.1	6.0	-0.1
WALL	232.6	1390.3	1390.5	.2	4.3	4.5	0.2
WALL	232.83	1390.4	1390.7	.2	4.2	4.4	0.2
WALL	232.9	1390.5	1390.8	.2	4.2	4.4	0.2
	233.0	1390.6	1390.8	.2	4.2	4.1	-0.1
	233.1	1390.6	1390.8	.2	4.2	4.1	-0.1
WALL	233.2	1390.6	1389.8	.2	5.8	6.2	0.4
WALL	233.23	1390.7	1391.0	.3	5.7	6.2	0.5
WALL	233.3	1390.8	1391.1	.3	5.7	6.1	0.4
	233.4	1390.6	1390.9	.3	7.2	7.0	-0.2
	233.94	1391.9	1392.1	.2	6.6	6.5	-0.1
	234.0	1392.3	1392.5	.2	6.4	6.3	-0.1
WALL	234.1	1392.4	1392.6	.2	6.0	6.5	+0.5
WALL	234.28	1393.3	1393.6	.3	5.5	5.8	+0.3
WALL	234.3	1393.4	1393.8	.4	5.5	5.8	+0.3
	234.4	1393.5	1395.9	.4	5.7	5.5	-0.2
	234.83	1395.0	1395.3	.3	5.1	5.0	-0.1
	235.5	1396.5	1396.5	.2	5.0	4.9	-0.1
	127.5	1396.6	1396.8	.2	5.8	5.7	-0.1
NEW BRIDGES	133.5	1396.8	1397.0	.2	2.6	2.9	.3
NEW BRIDGES	158.5	1397.0	1397.6	.6	3.5	4.5	1.0
NEW BRIDGES	182.5	1397.2	1398.0	.8	3.0	3.2	.2
NEW BRIDGES	190.5	1397.3	1398.1	.8	1.7	1.9	.2
NEW BRIDGES	203.0	1397.3	1398.1	.8	4.9	5.3	.4
NEW BRIDGES	205.0	1397.3	1398.1	.8	5.0	5.4	.4
NEW BRIDGES	206.0	1397.4	1398.2	.8	4.5	4.7	.2
NEW BRIDGES	209.0	1397.7	1398.5	.8	1.2	3.1	1.9
NEW BRIDGES	224.0	1397.8	1398.7	.9	2.5	3.1	+ .6
NEW BRIDGES	239.0	1397.5	1398.8	1.3	10.1	6.4	-3.7
NEW BRIDGES	240.0	1397.6	1398.8	1.2	10.0	6.4	-3.6
NEW BRIDGES	249.0	1398.9	1399.2	0.3	8.5	5.7	-2.8
NEW BRIDGES	269.0	1400.4	1400.3	0.1	3.4	6.1	+2.7
NEW BRIDGES	304.5	1400.7	1401.4	0.7	2.6	2.7	+ .1
	329.0	1401.0	1401.6	.6	4.0	4.3	.3
	363.5	1402.0	1402.8	.8	4.4	5.2	.8
	396.0	1403.4	1404.4	1.0	7.4	7.5	.1
	432.5	1406.3	1407.1	.8	6.5	6.1	.4

Q1972 - ALLEGANY RIVER-CATTARAUGUS COUNTY

SECTION NUMBER	WATER ELEV. EXIST.	WITH STE	DIFF. OF WATER EL.	CHANNEL VEL. EXIST.	WITH STE	DIFF. IN CH. VEL.
460.0	1408.2	1408.7	.5	5.8	5.5	.3
488.0	1409.2	1409.5	.3	7.3	7.0	.3
514.0	1410.3	1410.6	.3	6.7	6.6	.1
537.0	1411.1	1411.3	.2	9.2	9.0	.2
244.6	1411.8	1412.0	.2	8.3	8.2	.1
244.89	1412.7	1412.8	.1	7.8	7.7	.1
NEW BRIDGE 245.34	1414.0	1414.5	.5	7.2	6.9	-.3
245.78	1415.0	1415.4	.4	5.8	5.6	-.2
246.2	1415.7	1416.0	.3	6.5	6.3	-.2
246.67	1415.8	1416.1	.3	9.7	9.6	-.1
246.67	1416.0	1416.4	.4	9.6	9.4	-.2
247.0	1417.8	1418.1	.3	4.8	4.6	-.2
247.37	1418.0	1418.3	.3	8.4	8.3	-.1
247.38	1419.1	1419.4	.3	4.4	4.3	-.1
247.78	1419.6	1419.8	.2	5.4	5.3	-.1
248.17	1420.1	1420.3	.2	5.2	5.1	-.1

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